CONTAMINATION RISK ASSESSMENT FROM
WW II ARMOURY IN IRON BOTTOM SOUND
SOLOMON ISLANDS

FINAL TECHNICAL REPORT
PREPARED BY THE SOUTH PACIFIC APPLIED GEOSCIENCE COMMISSION (SOPAC)

SUBMITTED TO
THE UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP)
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SOPAC Technical Report 280

May 1999

Funded by

The Commonwealth Secretariat
under The Commonwealth Fund for Technical Co-operation (CFTC)

&

United Nations Development Programme (UNDP)
under United Nations Office for Project Services (UNOPS)
# TABLE OF CONTENTS

EXECUTIVE SUMMARY ........................................................................................................................... 7  
ACKNOWLEDGEMENTS .......................................................................................................................... 6  

INTRODUCTION ........................................................................................................................................ 9  

BACKGROUND AND STUDY AREA ...................................................................................................... 10  
  Background .............................................................................................................................................. 10  
  The Study Area ........................................................................................................................................ 11  

DURATION OF THE PROJECT .................................................................................................................. 11  

RESOURCE MATERIAL ............................................................................................................................. 11  

TASKS, METHODS AND TERMINOLOGY .............................................................................................. 11  
  Tasks .......................................................................................................................................................... 11  
  Methods .................................................................................................................................................... 13  
  A Cautionary Note .................................................................................................................................. 13  
  Terminology ............................................................................................................................................. 14  

RESULTS
  Bathymetry and Hydrography of Iron Bottom Sound ............................................................................ 14  
  Military Vessels and Ships Sunk ............................................................................................................. 15  
  Aircraft Destroyed .................................................................................................................................... 18  
  Volume/Tonnage of Wreck ....................................................................................................................... 20  
  Lives Lost ............................................................................................................................................... 21  
  Archival Photographs and Conditions of Submerged Wrecks ............................................................... 21  
  Cargo Contents ....................................................................................................................................... 22  
  Possible Environmental Impacts ............................................................................................................ 22  

CONCLUSIONS .......................................................................................................................................... 23  

RECOMMENDATIONS ............................................................................................................................... 24  

BIBLIOGRAPHY ........................................................................................................................................ 36  

REFERENCES CITED .................................................................................................................................. 39
List of Figures

Figure
1 Location map of Solomon Islands .............................................................. 12
2 The regional hydrography of Iron Bottom Sound, Solomon Islands .............................................................. 16
3 Bathymetry and hydrography of Iron Bottom Sound, Solomon Islands .............................................................. 17
4 Location map of some of the WW II wrecks in Iron Bottom Sound, Solomon Islands .............................................................. 19

List of Tables

Table
1 Naval battles fought over Iron Bottom Sound, Solomon Islands WW II .............................................................. 10
2 Catalog of Japanese Naval vessels sunk during operation Cactus, Iron Bottom Sound, Solomon Islands, WW II .............................................................. 26
3 Catalog of US Naval vessels sunk during operation Cactus, Iron Bottom Sound, Solomon Islands, WW II .............................................................. 30
4 Details of New Zealand Naval vessel sunk during operation Cactus, Iron Bottom Sound, Solomon Islands, WW II .............................................................. 32
5 Details of Australian Naval vessel sunk during operation Cactus, Iron Bottom Sound, Solomon Islands, WW II .............................................................. 32
6 Total number of US and Japanese naval vessels damaged and sunk and plane losses, WW II, Iron Bottom Sound, Solomon Islands .............................................................. 33
7 Aircraft types used in WW II, Iron Bottom Sound, Solomon Islands .............................................................. 34
8 Comparative table of the main types of fighter airplane, WW II, Iron Bottom Sound, Solomon Islands .............................................................. 35

List of Plates

Plate
1 Oblique aerial view, looking southwest of Cape Esperance, Guadalcanal’s northwest coast, Iron Bottom Sound .............................................................. 40
2 Oblique aerial view, looking east-northeast, of Henderson Field, Guadalcanal, October 1942 .............................................................. 41
3 The USS Chicago, a few hours before it was destroyed in the Solomons .............................................................. 41
4 The HM-NZS Tui, a New Zealand Navy minesweeper used primarily in anti-submarine operations during the Guadalcanal offensive 1942-1943 .............................................................. 42
5 Douglas, SBD-5 Dauntless-Dive Bombers in action .............................................................. 42
6 A squadron of Lockheed, PV-1 Ventura US fighter planes at Henderson Field, November 1942 .............................................................. 43
7 WW II photograph of Henderson Field, December 1942, with a Grumman, F4F-4 Wildcat fighter .............................................................. 43
8 Night action off Savo Island, 1st Battle of Savo, August 1942 .............................................................. 44
9 Japanese tanks destroyed by US artillery on October 1942, Matanikau River mouth, and north coast of Guadalcanal Island, Iron Bottom Sound .............................................................. 44
10 Air attack over Iron Bottom Sound, by Mitsubishi, G4M-1 Betty Bombers, 8th August 1942 .............................................................. 45
An underwater photograph of a section of a battleship in Iron Bottom Sound........................................45
An underwater photograph of a section of a battleship in Iron Bottom Sound........................................46
A diver inspects a sunken WWII naval wreck off Guadalcanal shores ......................................................46
Divers inspect the cockpit and control column of a US B-17E, *Flying Fortress Bomber* aircraft destroyed in Iron Bottom Sound, 24th September 1942 ..........................................................47
Underwater photograph of a section of an aircraft in Iron Bottom Sound ...................................................47
Underwater photograph of an aircraft in Iron Bottom Sound ..................................................................48
Underwater photograph of a Japanese submarine in Iron Bottom Sound ...................................................48
Underwater photograph of a Mitsubishi, *A6M Zero-Sen Zeke* aircraft in Iron Bottom Sound ...............49
Underwater photograph of the cockpit area of a Grumman, *F4F-4 Wildcat* aircraft in Iron Bottom Sound ..................................................................................................................................................49
Underwater photograph of the cockpit of a Grumman, *F4F-4 Wildcat* aircraft in Iron Bottom Sound ..................................................................................................................................................50
Remains of a US *F4F-4 Wildcat* fighter plane at the Vilu Village War Museum, west of Honiara, Guadalcanal ..................................................................................................................................................50
The *Kinugawa Maru*, a beached Japanese Navy transport vessel on the shores of Guadalcanal, 14th October 1942 ..................................................................................................................................................51
The *Hirokawa Maru*, a beached Japanese Navy transport vessel on the shores of Guadalcanal, 14th October 1942 ..................................................................................................................................................51
Rifle ammunition on one of the Japanese transport vessels in coastal areas of Iron Bottom Sound, north Guadalcanal ..................................................................................................................................................52
Preparing to destroy remaining WWII explosives on the north shores of Guadalcanal, Iron Bottom Sound ..................................................................................................................................................52

**Appendix**

Terms of reference for the project and SOPAC/UNDP contract ................................................................53
ACKNOWLEDGEMENTS

This project was supported by the Commonwealth Secretariat, under the Commonwealth Fund for Technical Co-operation (CFTC) and the United Nations Development Programme (UNDP), under its United Nations Office for Project Services (UNOPS). The Commonwealth Secretariat/CFTC funded the author.

Logistic and other financial support, from SOPAC, prior to commencement of this study and for the preparation of this technical report, is gratefully acknowledged.

Several people and institutions facilitated the collection of data for this project. These include, Sunita Prasad, SOPAC Librarian; The Embassy of Japan, Suva and Purnima Chandra, Senior Library Assistant, University of the South Pacific (USP) Main Library, Suva, Fiji.

From the United States of America, Lynette Furuhashi, Pacific Specialist, Hamilton Library, University of Hawaii, Manoa; Ross Tagashi, Cartographer, Hamilton Library, University of Hawaii, Manoa; Patty Belcher, Librarian and DeSoto Brown, archivist, Bishop’s Museum, Honolulu, Hawaii; Librarian, East-West Centre, Honolulu, Hawaii; U. S. Naval Institute, Maryland and Pat Wilde, Berkeley, California.

From Japan, Yoshitaka Hosoi, Japan Mining Engineering Centre for International Cooperation, Tokyo, Japan; Akira Kado, The National Diet Library, Tokyo, Japan; Masahiro Kawai, Military History Department, National Institute for Defence Studies, Tokyo, Japan and The Chief Librarian, Main Library, Kyoto University, Japan.

From Solomon Islands, Vilimanina Vakaciwa, Librarian, USP Centre, Honiara, Solomon Islands; Don Tolia and Rennel Magu, Director and Deputy Director respectively, Department of Energy, Water and Mineral Resources, Ministry of Natural Resources, Solomon Islands Government (SIG); Edmund Gagahe, Secretary to the Ministry of Natural Resources, Solomon Islands Government (SIG); Nairie Alamu, Secretary to the Ministry of Foreign Affairs and Trade, SIG; Clifford O lisukulu, Chief Hydrographic Surveyor, Ministry of Land and Housing, SIG; Haiku Baiabe, Secretary, Ministry of Home Affairs, SIG; Adrian Bataofesi, former member of Parliament, SIG; Robert Aunama, Solomon Islands Visitors Bureau, Ministry of Tourism, SIG; National Archives and National Museum, SIG. Discussions with divers Paul Hobbs, Cable and Wireless, U.K. and Frank Boulay, Island Dive, Honiara, Solomon Islands are gratefully acknowledged.

The author is also grateful to Mr. Kevin Dixon and Mr. Chris Carlton, Chief Geodetic Surveyor and Hydrographic Surveyor respectively, United Kingdom Hydrographic Office for the provision of chart datum and navigational corrections for Iron Bottom sound.

Technical assistance of Olivier Duperray and Anna Elaise, SOPAC’s Information Technology Unit, in digital map preparation and Sisilia Gravelle, Coastal Unit, in image scanning is gratefully acknowledged.

This is SOPAC’s Project SB 99.03 - Solomon Islands.
EXECUTIVE SUMMARY

The Solomon Islands Government (SIG) requested the South Pacific Applied Geoscience Commission (SOPAC) to conduct a contamination risk assessment study of World War II (WW II) sunken vessels/ships and aircraft in Iron Bottom Sound, Solomon Islands.

The study area is defined as the sea area which lies between lines of longitude 159° 43’ E and 160° 25'E and between latitude of 8° 58’ S, to the north of Iron Bottom Sound, and Guadalcanal Island, which lies to the south of Iron Bottom Sound. The area is about 3500 km².

The purpose of this study is to collate the existing/documented information on the military vessels and aircraft which were sunk and destroyed in Iron Bottom Sound, Solomon Islands, and assess the possible risk of contamination to the coastal and marine environment in the area. This information will then be used to evaluate the possible environmental impacts of WW II military hardware and armoury on the natural and human environment and assist in the developing of optimum management strategies for utilisation of the said areas.

The duration of the project was four (4) months. The project began on 4th January, 1999 and ended on 15th May, 1999.

Information was collected from published/public information, from maps, atlases, charts, aerial photographs, books and journals held in international libraries and national archives.

The main tasks identified for this phase of the project:

- Compile as complete an inventory as possible, on the number of vessels, their location, type/s and probable cargo content, using data from as wide a variety of sources as possible.
- Develop a database, in computerised GIS, using MapInfo software, with overlays of vessel location, water depth and oceanographic conditions (where available), such as currents and water quality.
- Identify, from preliminary assessment, areas of potential environmental impact.
- Define a follow-up work program, as deemed necessary, for further field investigations of selected areas to assist in developing sustainable planning and management strategies for the coastal and marine areas.

Results of a contamination risk assessment study in Iron Bottom Sound have shown that:

- 111 Japanese, American and New Zealand naval vessels were destroyed and sunk.
- This comprises 65 Japanese, 44 American, 1 Australian and 1 New Zealand vessel.

In addition,

- 1450 fighter planes (1120 Japanese and 330 American) were destroyed and
- 15 000-20 000 military personnel were killed in the Sound.

Of 52 wrecks with known bathymetric locations,

- 10 are in water depth of less than 100 m;
- 8 in 100-500 m;
- 31 in 500-1000 m; and
- 3 in water greater than 1000 m deep.
Calculation of the volume/tonnage (T) of debris, which littered the seabed of the Sound, indicates a cumulative mass of 446,517 t of metal from the 111 sunken vessels. Of this,

- 321,822 t is from the Japanese,
- 115,795 t from the American, and
- the remaining wrecks from the Australian and New Zealand vessels.

Investigations show that the shallow water wrecks are extremely corroded and are heavily colonised by benthic species, including corals, green, red and brown algae and other macro-benthic dwellers. For the deeper wrecks, corrosion does not appear to be as aggressive as for those wrecks in shallow water. This is largely due to less available oxygen in these deeper waters, in some cases, down to 1000-1200 m. As a result, these deeper wrecks are more intact than their shallow-water counterparts.

The specific cargo contents of the various military vehicles, which were part of the Guadalcanal Offence, are unknown. For the various armed forces which participated in the Guadalcanal campaign, several types of cargo were common. These include rifle ammunition, bombs, torpedoes, explosives, land and sea mines, naval artillery ammunition, engine and lubricating oils, diesel oil and other fuel.

Much of these cargo contents of the sunken vessels and aircraft were destroyed before and during sinking. Since many aircraft were shot down and ships were bombed or torpedoed, many of these military arsenals were set on fire and partly burnt at sea, before coming to rest in their watery grave. Consequently, much fuel, oil and explosives was destroyed in this process. However, some of this material may still be present in many of the deeper wrecks.

Divers on many of the shallow wrecks report oil and rifle ammunition on several of the shallow wrecks, while land-sea mine explosives have also been recovered and destroyed, on the same north coast of Guadalcanal.

The military hardware, munitions and possible fuel and oil from the various vessels represents possible contamination risk to natural communities. Sources of risk and pollutants include the leakage of oils and fuel, leaching of trace elements and heavy metals from paints, corroded aircraft and ships and munitions.

These represent a real source of pollution to the natural environment. To determine if these petroleum hydrocarbons and metals are affecting the biophysical environment requires analysis of water and sediment and possibly, toxicological tests, depending on the level of petroleum hydrocarbons in the local environment. Since these types of data are not available, further comments cannot be made at this time.

Based on the physical characteristics and the location and possible distribution of WWII wrecks in Iron Bottom Sound, further and detailed assessment of environmental impacts and contamination risk, especially specific risk, should incorporate additional environmental variables. These variables will assist in further understanding of wreck distribution and their possible levels of contamination to the coastal and marine environment.

Based on the available bathymetric distribution of some of the wrecks, and the relatively deep ocean in Iron Bottom Sound, it is recommended that further studies be concentrated in the shallow nearshore/coastal areas. These areas, are the zones of high biological productivity and concentration of marine biota, including reef species. They are also the areas most assessable to people on the surrounding islands and the area in which human contact is the most frequent.

Further studies should include,

- further information on the location of nearshore wrecks, especially within the 100 m bathymetric contour, for which positions are unknown;
Contamination Risk Assessment, Iron Bottom Sound, Solomon Islands

- identification of the areal distribution of nearshore wrecks by swath or sonar mapping;
- assessment of the nature of ecosystems in the above-mentioned nearshore areas; and
- assessment of the levels of contamination of nearshore water and sediments, by various trace and heavy metals and petroleum hydrocarbons (both dissolved and dispersed petroleum hydrocarbons) which may be leaching from nearshore vessels into the surrounding water masses and sediment.

The assessment of water and sediment chemistry parameters should utilise control stations, from which background/normal concentration of the various chemical parameters can be assessed. If this is not done, assessment of water and sediment contamination will be meaningless.

For sound environmental management of the nearshore and marine areas, and to facilitate a rational use of the nearshore resources of the area, the assessment of the above parameters should be done. Only then can optimum environmental management strategies be drafted and formulated for the study area.

1.0 INTRODUCTION

The Solomon Islands Government (SIG) requested the South Pacific Applied Geoscience Commission (SOPAC) to conduct a contamination risk assessment study of World War II (WW II) sunken vessels/ships and aircraft in Iron Bottom Sound, Solomon Islands.

The project was submitted by SIG to the United Nations Development Programme (UNDP), and accepted for funding by UNDP under its United Nations Office for Project Services (UNOPS), SOPAC being the implementing and executing agency.

The terms of reference for this project are contained in attachments to UNDP Reference: INT/96/705/YX and Contract Number C-98-2250 (Appendix 1) and in SOPAC’s 1999 work program, as SOPAC Project SB 99.03.

This document is the final project report for this study, highlighting data collected during two field visits, one to Honolulu, Hawaii from 8 to 17 January, 1999, and the other to Honiara, Solomon Islands, from 23 to 30 January 1999.

This report presents inventories of Japanese, American, Australian and New Zealand military vessels and ships sunk in Iron Bottom Sound. Aircraft types and number destroyed, a location map of wrecks with known positions and estimates of the total tonnage of metal which may have accumulated due to sinking of these vessels are also presented.

The report also presents in digital format (in MapInfo GIS and MS Assess software) data on the bathymetry/hydrography of Iron Bottom Sound, possible water circulation pattern, condition of the sunken vessels, possible contamination risk and environmental problems.

In addition, a proposal for further work is discussed, to assist in developing sustainable planning and management strategies for the coastal and marine areas in Iron Bottom Sound.
2.0 BACKGROUND AND STUDY AREA

2.1 Background

Many areas within the South Pacific were subject to intense military activity and battles during *WW II*, resulting in the sinking of numerous military ships, vessels and aircraft.

*The Pacific Theatre*, as the area was later described by the military of the day, was the stage for some of the most disastrous naval battles fought, to date. This includes the *Battle of Savo Island, August 7-9, 1942*, which has been described by military specialists as the worst U. S. Navy (Naval) defeat to date.

The Solomon Islands was one country where fighting, over several years, between the Allied Forces (USA, Australia and New Zealand, led by the Americans - The US Army, Navy and Marines) and the Japanese, saw the loss of numerous military ships and aircraft in marine and coastal waters.

Several of the battles fought in the Solomon Islands during *WW II*, between August and December 1942, were centred on Guadalcanal Island, in particular, Iron Bottom Sound.

In south-east Solomon Islands, on Guadalcanal Island and surrounding coastal and marine areas, some of the most intense military campaigns (code-named operation *Cactus* by the U. S. military) were fought. These were the *Battles of Savo Island, Cape Esperance, Guadalcanal I and II and the Battle of Tassafaronga*, also referred to in military books as the *Battles of Savo I, II, IV and V* (Table 1).

These battles were fought over five months, between August 7th, 1942 and December 1st 1942 (Table 1). This culminated in the defeat, and retreat of the Japanese, by Allied Forces in Solomon Islands and the South Pacific in February 1943.

A total of 188 minutes of intense military assault was launched during these five battles, with numerous losses to military personnel, defence aircraft, battleships and other naval hardware. All five battles were fought at sea and involved largely naval military. Consequently, most losses were in the coastal and marine areas between Guadalcanal Island and the Florida Islands, now referred to as Iron Bottom Sound.

The name, Iron Bottom Sound, was coined after *World War II*, following the sinking of numerous battleships, aircraft and other military iron hardware of *WW II* in the said marine area. It describes the watery graveyard of the numerous ‘iron” wrecks which have accumulated in the Sound.

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**Table 1. Naval battles fought over Iron Bottom Sound, Solomon Islands WW II.**

<table>
<thead>
<tr>
<th>BATTLES FOUGHT</th>
<th>DATES</th>
<th>DURATION, mins</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Battle of Savo/Savo Island</td>
<td>42.8.7 - 42.8.8</td>
<td>45</td>
</tr>
<tr>
<td>2nd Battle of Savo/Cape Esperance</td>
<td>42.10.11 - 42.10.12</td>
<td>31</td>
</tr>
<tr>
<td>3rd Battle of Savo/Guadalcanal I</td>
<td>42.11.11 - 42.11.14</td>
<td>32</td>
</tr>
<tr>
<td>3rd Battle of Savo/Guadalcanal II</td>
<td>42.11.14 - 42.11.15</td>
<td>51</td>
</tr>
<tr>
<td>4th Battle of Savo/Tassafaronga</td>
<td>42.11.30 - 42.12.1</td>
<td>29</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>42.8.7 - 42.12.1</strong></td>
<td><strong>188 mins</strong></td>
</tr>
</tbody>
</table>
For those military ships and aircraft which were sunk, little is known of about the total numbers, their location and cargo content at the time of sinking. In addition, the potential environmental risks posed by these wreckage to marine bio-diversity, commercial fishery resources, tourism, and other coastal and marine-based economic activities in Iron Bottom Sound is unknown.

The purpose of this study is to collate the existing/documentated information on the military vessels and aircraft which were sunk and destroyed in Iron Bottom Sound, and assess the possible risk of contamination to the coastal and marine environment in the area.

This information will then be used to evaluate the possible environmental impacts of WWII military hardware and armour on the natural and human environment and assist in the developing of optimum management strategies for utilisation of the said areas.

2.2 The Study Area

The study area is Iron Bottom Sound (Figure 1), located north of Guadalcanal Island and south and west of Florida Islands. Savo Island lies in the mid-west of the study area and is a sub-aerial volcano.

The study area is defined as the sea area (coastal and marine areas) which lies between lines of longitude 159° 43' E and 160° 25'E, and between latitude 8° 58' S, and Guadalcanal Island, which lies to the south of Iron Bottom Sound. The sea area is about 3500 km².

3.0 DURATION OF THE PROJECT

The project duration was about four months. The project began on 4th January, 1999, and ended on 15th May, 1999 (UNDP reference: INT/96/705/YX and Contract Number C-98-2250; Appendix 1).

4.0 RESOURCE MATERIAL

Information was collected from published/public information, from maps, atlases, nautical charts (1942 - WWII), black and white aerial photographs, military books and journals held in international libraries and national archives.

These include military archives in the USA; Bishop Museum Hololulu and the University of Hawaii, Manoa USA; military departments in Tokyo, Japan; and information from the SIG, Honiara.

5.0 TASKS, METHODS AND TERMINOLOGY

5.1 Tasks

The following are the main tasks identified for this phase of the project:

- Compile as complete an inventory as possible, on the number of vessels, their location, type/s and probable cargo content, using data from as wide a variety of sources as possible.
- Develop a database, in computerised GIS, using MapInfo software, with overlays of vessel location, water depth and oceanographic conditions (where available), such as currents and water quality.
Figure 1. Location map of Solomon Islands and Iron Bottom Sound.
5.2 Methods

Information was collected from several sources, during two field trips. One trip was made to Honolulu, Hawaii, from 8 to 17 January, 1999, and the other to Solomon Islands, from 23 to 30 January 1999.

Over eighty publications were reviewed. These are listed in the bibliography, Section 9.0 of this report. All references contained in this list were seen by the author and form the basis of this report.

In Fiji, publications were reviewed from the Pacific and Reference Collection, University of the South Pacific (USP) Main Library.

In Honolulu, information was collected from the Pacific Collection, Maps and Aerial Photograph Sections and General Map Collection of the Hamilton Library, University of Hawaii, Manoa. In addition, publications and aerial photos were reviewed at the Bishop Museum, Honolulu, and the Main Library, East-West Center, Honolulu.

In Honiara, Solomon Islands, information was obtained from the USP Centre; Chief Hydrographic Surveyor, Ministry of Land and Housing; the Visitors Bureau, Ministry of Tourism, SIG; the National Archives; and National Museum, SIG.

Publications were procured from several agencies in Japan. These represent the best sources of information for the Japanese military operations in Solomon Islands. All documents and records obtained were in Japanese and were translated by the author.

Agencies in Japan which were consulted are the Japan Mining Engineering Center for International Cooperation, Tokyo; The National Diet Library, Tokyo; the Military History Department, National Institute for Defence Studies, Tokyo; the Main Library, University of Tokyo, Tokyo; and The Main Library, Kyoto University, Kyoto.

Several publications and information were obtained from the United States Naval Institute (USNI), Maryland, U.S.A. (http://www.usni.org). E-mail address: ADBDPT@AOL.com. The USNI has published numerous accounts of military operations in the Pacific Theatre, WWII, in particular a number of well-referenced volumes on Guadalcanal (see Section 9.0 for reference to several of these volumes).

5.3 A Cautionary Note

It is noteworthy to mention that in collecting of the data for this project, it was found that there were several variations in the annals of war written by the Japanese, Americans and other military historians. This include information on the total number of vessels sunk, their location and possible final resting places and in some instances, the date some were sunk. In many cases, the search for documented information was almost analogous to looking for the proverbial needle in a haystack.

For this report, the records procured from the Japanese and American military are thought to be the most accurate of their respective operations during the military events which transpired in the Solomon Islands and the Pacific Theatre during WW II. Further, these records are thought to be superior to any others written on the subject.
In light of the above, the arduous reader is urged to use with caution, the tabulated results contained in this report.

This report is not intended as a field guide to sunken ships and military arsenal of Iron Bottom Sound, Guadalcanal, Solomon Islands.

5.4 Terminology

For the purpose of this study, the definition of risk is important, so as to sensitise the reader and the users of this report to the context in which it has been interpreted and used.

The perception of risk, by individuals, is influenced by a number of factors.

People perceive risks differently, depending on the likelihood of a hazard having adverse effects; how widespread, familiar, and dreaded the effects are; how a hazard affects individuals personally and whether they have agreed to bear the risks (Slovic, 1986).

For the purposes of this study and for clarity, the term risk is defined as follows:

- Risk is defined as the possibility of suffering harm from a hazard.
- A hazard is a source of risk and refers to a substance or actions that can cause harm (Nathan and Bronstein, 1998).

Risk assessment refers to the technical assessment of the nature and magnitude of risk (NRC, 1989). In the case of this study, it is the technical assessment of possible contamination of the natural environment by various materials degrading, leaching and being discharged from military hardware/armour in Iron Bottom Sound. The possible hazard in this case is the presence of WWII military hardware in Iron Bottom Sound.

Although risk analysis is sometimes used synonymously with risk assessment, it is used here to include methods of risk assessment, as well as methods to best use the resulting information and data.

6.0 RESULTS

6.1 Bathymetry and Hydrography of Iron Bottom Sound

The hydrography of the study area is taken from Hydrographer of the Navy (1989). Iron Bottom Sound represents an eastern extension of the New Georgia Sound and Central Solomon Trough (Figure 2). The Central Solomon Trough is a southeast-trending ocean trough, that can be traced further west to Bougainville and to the eastern part of the Solomon Islands. This area is a tectonically controlled fracture zone, and represents part of the plate boundary where the Indo-Australian and Pacific Plates meet.

Compressional and oblique forces affect this plate boundary in this part of the Pacific. The plate boundary here is a largely convergent margin of oceanic-oceanic lithosphere material. Consequently, the sea floor in this area and in Iron Bottom Sound is very narrow in comparison to its length, forming a classic ocean trough, with steep side slopes under deep ocean water (Figure 3).

The sea area of Iron Bottom Sound delineated for this study corresponds to an area 24 km wide in the east and 42 km wide in the west, giving it a funnel shape (Figure 3).
The Sound is about 80 km long along its main axis, which trends northwest.

The bathymetry of Iron Bottom Sound shows a generally cone-shaped morphology, with shallower areas in the east and deeper areas to the west. Consequently, there is a natural gradient and corresponding gravity flow of deep water to the west and northwest.

To the east, water depth varies between 50 and 90m in the shallow nearshore areas. These areas consist of numerous shoals and reef areas, both in Lengo Channel, north of Guadalcanal Island, and in Nggela Channel, to the immediate south of Nggela Pile in the Florida Islands Group (Figure 3). In addition, the southern side of the Sound is also shallow and is colonised by coral reef species, e.g. Plate 1*.

The shoals on the southern side of the Sound support several coral reefs and other benthic reef biota in the more photic zones (less than 30 m of water). Between these shallow areas, water depth increases sharply, down to 320-360 m, in the Sealark Channel, an eastnortheast-trending (075°) trench. Slope gradients across these deep areas are estimated to be greater than 10°. Slope is to the southwest/255°, in the Sealark Channel, with estimated gradient of 1°.

The western and central part of Iron Bottom Sound is significantly deeper, with only narrow sections of shallow coastal waters, averaging 0.5-1 km wide. Beyond 1 km from the Guadalcanal and Savo Island shores, slopes become progressively steeper, with water depths of up to 800 m in the central part of the Sound, and up to 1225 m to the northwest part of the Sound. In these areas, slope is also to the northwest (Figure 3). Estimated slope in the central and western part of the Sound varies between 0.8 and 1°.

Due to the natural gradient to the west and northwest, deep-water circulation will be significantly influenced by gravity, causing a predominant westerly flow. In shallower areas, like on the shoals north of Guadalcanal Island and Nggela Pile, in addition to tidal streams, predominant winds and waves, will influence flow. As a result of tidal variations, currents change directions with falling and rising tides, as shown by opposite arrows on the shoal areas in Figure 3. Bottom current flow of 2-3 knots (3.88-5.82 m s⁻¹) has been noted in these areas by hydrographic survey vessels (Hydrographer of the Navy, 1989 and Figure 3).

### 6.2 Military Vessels and Ships Sunk

Tables 2-5* present the results of the literature review and inventories of Japanese, American, Australian and New Zealand naval vessels which were destroyed and sunk in Iron bottom Sound.

Based on records reviewed,

- 65 Japanese;
- 44 America;
- one Australian and
- one (1) New Zealand vessel were sunk in the study area.

This gives a total of 111 naval vessels destroyed. In addition, 154 Japanese and 37 American vessels were damaged, contributing further wreckage to the already littered seabed (Table 6).

However, records obtained from the U.S. military, in particular data presented in Harms (1987), and written by the Commander in Chief of the Pacific Fleet, Admiral Chester W. Nimitz, dated 17th April 1943, indicates that 121-145 vessels were destroyed (Table 6) during the five battles fought in August-December 1942. The additional 10-34 naval vessels destroyed, as suggested by these records, are not known. In addition, the poor data quality and variations in available records by both the Japanese and Americans, as documented in various publications, do not facilitate any clarifications of this information.

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*For Plates see from page 40 to page 52, and for Table 2 onwards see from page 25 to page 35.


15
Japanese military records show that many additional naval vessels were destroyed during the “Solomon War” of 1942-1943. However, these records also indicate that the exact locations of these vessels are not known, while some give estimated locations out of the study area, at several degrees west and north from Iron Bottom Sound. It is the author’s opinion that any inclusion of these uncertain data be discouraged.

From the Japanese Navy (J), 65 vessels were sunk. These were:

- 21 destroyers (DD) (for abbreviations see next page);
- 3 heavy cruisers (CA);
- 2 battleships (BB);
- 6 submarines (JS);
- 5 transport vessels (AP/APD);
- 20 supply/transport vessels (JT);
- 1 landing tank (LST);
- 2 cargo ships (AK);
- 1 light cruiser (CL);
- 1 carrier (CV) and
- 2 craft of unknown designation (Table 2).
Figure 3. Bathymetry and hydrography of Iron Bottom Sound, Solomon Islands (extracted from Hydrographer of the Navy, 1989, Chart 1713, Scale 1:100,000 at latitude 9°15'). All data shown were reduced to Chart datum, approximately the level of Lowest Astronomical Tide (LAT). The positions of this sheet were based on Directorate of Overseas Survey Datum (1960). Positions obtained using differential Global Positioning System (GPS), normally referred to as WGS (World Geodetic System) 84, should be adjusted as follows, to agree with the data on this chart: move 0.414’ Northwards and 0.061’ Westwards (Kevin Dixon, Chief Geodetic Surveyor, U.K. Hydrographic Office, personal communication).
From the US Navy (US), 44 vessels were sunk. These were,

- 20 destroyers (DD);
- 8 heavy cruisers (CA);
- 8 transport vessels (AP/APD);
- 1 tug;
- 1 light cruiser (CL) and
- 6 patrol vessels (PT) (Table 3).

One heavy cruiser (CA) from the Royal Australian Navy (RAN) the *HMS Canberra*, and one mine-sweeper, from New Zealand (NZ) *Moa*, were also sunk (Tables 4 and 5).

From the records presented in Tables 2-5, vessels sunk comprise

- 44 destroyers (DD);
- 12 heavy cruisers (CA);
- 2 battleships (BB);
- 6 Japanese submarines (JS);
- 13 transport vessels (AP/APD);
- 20 Japanese transport (JT);
- 1 landing tank (LST);
- 2 cargo ships (AK);
- 1 light cruiser (CL);
- 1 carrier (CV);
- 1 tug;
- 1 mine sweeper and
- 2 unknown naval vessels.

The summary presented in Table 6 and extracted from Harms (1987) shows some variations from the above figures. This table shows a larger number of Japanese vessels and a smaller number of American vessels sunk in Iron Bottom Sound. At this point, data are not available for clarification of this aspect.

Figure 4 shows the location of some of the Japanese and American vessels sunk in the study area. Only those vessels for which good-quality location data exist are shown here. Since the latitude and longitude of most of the vessels destroyed are not known, their positions cannot be plotted on a map.

Analysis of the data presented in Tables 2-5 and Figure 4 shows that of vessels for which bathymetric records are available (52), most are found in water depth greater than 100 m (42 or about 80% of the total for which depth are known). These are as follows:

- 10 vessels in 0-100 m depth of water, of which 5 were beached,
- 8 vessels at 100-500 m,
- 31 vessels 500-1000 m and
- 3 vessels in water depths greater than 1000 m.

### 6.3 Aircraft Destroyed

Tables 7 and 8 present lists of the various aircraft used by the military in the five Guadalcanal battles fought from August 7th to December 1st 1942.
Figure 4. Location map of some of the WWII wrecks in Iron Bottom Sound, Solomon Islands.
Records obtained from the U. S. military, in particular data presented in Harms (1987), and written by the Commander in Chief of the Pacific Fleet, Admiral Chester W. Nimitz, dated 17th April 1943, indicate that 330 American and 1120 Japanese planes were shot down in the study area (Table 7). This gives a total of 1450.

Most of these were shot down over Iron Bottom Sound. However, the locations of these military aircraft are not known.

### 6.4 Volume/Tonnage of Wreck

Of the 111 vessels which are tabulated in Tables 2-5, 66 have tonnage information (T = short tons). These records are more complete for the Japanese Navy vessels than the American Navy.

Fifty-six of the 65 Japanese vessels have tonnage records. For the tonnage indicated in Table 2, their cumulative weight is 292 463 T. For the American vessels, 10 of which have tonnage records, their cumulative weight is 60 615 T. This gives a sub-total of 353 078 T of metal wreck.

For the remainder of the Japanese and American vessels which have no tonnage data, estimates were made, using averages from vessels of similar class/category.

For the Japanese Navy the following was obtained:

- 1 class/category CA vessel @ 7100 T  
  7100 T
- 1 class/category CL vessel @ 1800 T  
  1800 T
- 3 class/category JS vessel @ 1953 T  
  1953 T
- 1 class/category DD vessel @ 1800 T  
  1800 T
- 1 class/category CV vessel @ 1800 T  
  1800 T
- 2 class/category CT vessel @ 5500 T  
  11 000 T

This gives a total of nine Japanese vessels, with a sub-total of 29 359 T.

For the American Navy (USN) the following was obtained:

- 4 class/category PT vessel @ 45 T  
  180 T
- 1 class/category CL vessel @ 1800 T  
  1800 T
- 2 class/category CA vessel @ 7100 T  
  14 200 T
- 6 class/category AP vessel @ 200 T  
  1200 T
- 21 class/category DD vessel @ 1800 T  
  37 800 T

This gives a total of 34 USN vessels, with a sub-total of 55 180 T.

In addition, the one RAN and one NZ vessel are estimated to have weights of 7100 T and 1800 T respectively.

The total estimated tonnage for the additional 45 vessels is 93 439 T. This gives a total tonnage of metal wreck, for the 111 naval vessels, of 446 517 T.
6.4 Lives Lost

In addition to the metal/iron wrecks sunk in Iron Bottom Sound, thousands of soldiers were killed while fighting. These represent an additional contribution to the seabed carnage of the area.

Data presented in Harms (1987), and written by the Commander in Chief of the Pacific Fleet, Admiral Chester W. Nimitz, dated 17th April 1943, indicated that over 35,000 lives were lost during the battles which were fought between August-December 1942. These records also indicate that 15,000-20,000 lives were lost at sea, in Iron Bottom Sound.

6.5 Archival Photographs and Condition of Submerged Wrecks

Plates 2-25 show typical examples of WWII and recent photographs of military operations, vessels and aircraft from Iron Bottom Sound, Solomon Islands.

Plates 3 and 4 show examples of typical destroyers and navy mine-sweepers which fought in the naval battles of Guadalcanal. Plates 5-7 show examples of airborne fighter planes, from the Pacific Ocean command of the US airforce, 1942. Plate 21 show and example of a US F4F-4 Wildcat fighter on Guadalcanal. Typical scenes of naval and air attack are shown in Plates 8-10.

The condition of most wrecks in Iron Bottom Sound is yet unknown. Professional and amateur divers alike have inspected the shallow wrecks. In addition, at least a dozen of the deep water wrecks were surveyed by Robert Ballard, in 1992, using underwater video photography and two ROV (remotely operated vehicle), the Sea Cliff and the Scorpio, both developed for deep sea exploration.

These investigations show that the shallow water wrecks are extremely corroded and are heavily colonised by benthic species, including corals, green, red and brown algae and other macro-benthic dwellers. Typical examples of these encrustation and colonisation of wreck debris are shown in Plates 11-20 and Plate 24. In addition, sections of many wrecks are fragile and falling apart due to aggressive corrosion in sea water. Many of these wrecks serves as FADS (fish aggregating devices), also serving to increase the biological productivity of the local area. In addition, they attract a considerable number of sport and professional divers each year.

Divers on many of the shallow wrecks also report seeing oil escaping from several of these wrecks, in particular the Hirokawa Maru and Kinugawa Maru (Plates 22 and 23 respectively). For these particular wrecks, which are both lying right way up, there may still be oil and fuel inside the vessel. In addition, other similar vessels, which were not completely destroyed and were sunk, may also contain fuel and oil.

For the deeper wrecks for which some limited data exists, corrosion does not appear to be as aggressive, as for those wrecks closer to shore and in shallow water. This is largely due to less available oxygen in these deeper water, and less corrosion of these deep wrecks, in some cases, down to 1000-1200m. As a result, these deeper wrecks are more intact than their shallow water counterpart. This suggests that some of the contents of these vessels may also still be aboard, less those which may have burnt before sinking and which may have gone afloat or transported out of the vessels by strong, deep water currents.

The relatively sediment free nature of the surface of these deep water wrecks suggests that these sites are well flushed by bottom currents. In addition, the growth of several macro-benthic biota also suggest good circulation and available oxygen.
6.6 Cargo Contents

The specific cargo contents of the various military, which were part of the Guadalcanal Offence, are unknown. For the various navies and armed forces which participated in the Guadalcanal campaign, several types of cargo were common. These include, but are not limited to:

- Rifle ammunition,
- Aircraft bombs,
- Torpedoes,
- Explosives,
- Land and sea mine explosives,
- Naval artillery ammunition,
- Engine and lubricating oils,
- Diesel,
- Fuel,

Much of these cargo contents of the sunken vessels and aircraft were destroyed before and during sinking. Since many aircraft were shot down and ships were bombed or torpedoed, many of these military arsenal were set on fire and partly burnt at sea, before coming to rest in their watery grave. Consequently, much fuel, oil and explosives were destroyed in this process. However, some of this material may still be present in many of the deeper wrecks.

Divers on many of the shallow wrecks report oil escaping from several of these wrecks, in particular the Hirokawa Maru and Kinugawa Maru (Plates 22 and 23 respectively). Other vessels, which were not completely destroyed may also contain fuel and oil.

Divers have also noted rifle ammunition on several of the shallow wrecks, off the north coast of Guadalcanal, e.g. Plate 24. In addition, land-sea mine explosives have also been recovered and destroyed, by Solomon Island Police, on the same north coast of Guadalcanal, bordering Iron Bottom Sound (Plate 25). The volume of these munitions nor are their real distribution are known. Consequently, further comments are not possible at this time.

6.6 Possible Environmental Impacts

The presence of any foreign substance in the marine and coastal environment can pose a threat to natural ecosystems. In the case of Iron Bottom Sound, the presence of military hardware, munitions and possible fuel and oil from the various vessels represent possible contamination risk to natural communities.

To identify the real risk however, requires further information on the real distribution of the various hazards (the source of risk), in this case, the military arsenal and their contents. Without information on these parameters, it is not possible to clarify the perceived risk and quantify the real risk to the natural systems and human communities. Without such data, only general comments can be made.

Sources of risk and pollutants include:

- The leakage of oils and fuel,
- The leaching of trace elements and heavy metals from corroded aircrafts and ship’s,
- The leaching of paints from aircrafts and ship’s and
- The leaching of metals from munition.
These represent a real source of pollution to the natural environment. To determine if these petroleum hydrocarbons and metals are affecting the biophysical environment, requires analysis of water and sediment chemistry and possibly, toxicological tests, depending on the level of petroleum hydrocarbons in the local environment. Of course, these analytical data must be compared with background levels of hydrocarbon and metals, from control stations, in the coastal and marine environments, to determine if the present levels are higher or lower than normal background levels. Only then can this type of analysis be meaningful.

Since these types of data are not available, further comments cannot be made at this time. Speculation on possible environmental impacts and problems should not be encouraged, as impacts (both positive and negative) are site specific and are dependent on the local environmental conditions.

7.0 CONCLUSIONS

Results of a contamination risk assessment study in Iron Bottom Sound have shown that 111 Japanese, American and New Zealand naval vessels were destroyed and sunk in Iron Bottom Sound. These include 65 Japanese, 44 American, 1 Australian and 1 New Zealand vessel. In addition, 1450 fighter planes and bombers (1120 Japanese and 330 American) were also shot down, while 15,000-20,000 military personnel were killed and were sunk in the Sound.

Of the 52 wrecks with known locations,

- 10 are in water depth of less than 100 m,
- 8 in 100-500 m;
- 31 in 500-1000 m; and
- 3 in water greater than 1000 m deep.

Calculation of the volume/tonnage (T = short tons) of debris, which littered the seabed of the Sound, indicates a cumulative volume of 446,517 T of metal from the 111 sunken vessels. Of this,

- 321,822 T are from the Japanese,
- 115,795 T from the American,
- the remaining wrecks from the Australian and New Zealand vessels.

Investigations show that the shallow water wrecks are extremely corroded and are heavily colonised by benthic species, including corals, green, red and brown algae and other macro-benthic dwellers. For the deeper wrecks, corrosion does not appear to be as aggressive, as for those wrecks in shallow water. This is largely due to less available oxygen in these deeper water, in some cases, down to 1000-1200 m. As a result, these deeper wrecks are more intact than their shallow water counterpart.

The specific cargo contents of the various military, which were part of the Guadalcanal Offence, are unknown. For the various armed forces which participated in the Guadalcanal campaign, several types of cargo were common. These include rifle ammunition, bombs, torpedoes, explosives, land and sea mines, naval artillery ammunition, engine and lubricating oils, diesel and fuel.

Much of these cargo contents of the sunken vessels and aircraft was destroyed before and during sinking. Since many aircraft were shot down and ships were bombed or torpedoed, much of the military arsenal was set on fire and partly burnt at sea, before coming to rest in their watery grave. Consequently, much fuel, oil and explosives was destroyed in this process. However, some of this material may still be present in many of the deeper wrecks.
Divers on many of the shallow wrecks report oil and rifle ammunition on several of the shallow wrecks while, land-sea mine explosives have also be recovered and destroyed, on the same north coast of Guadalcanal.

The presence of military hardware, munitions and possible fuel and oil from the various vessels represent possible contamination risk to natural communities. Sources of risk and pollutants include, the leakage of oils and fuel, leaching of trace elements and heavy metals from paints, corroded aircraft's and ship's and munition.

These represent a real source of pollution to the natural environment. To determine if these petroleum hydrocarbons and metals are affecting the biophysical environment, requires analysis of water and sediment chemistry and possibly, toxicological tests, depending on the level of petroleum hydrocarbons in the local environment. Since these types of data are not available, further comments cannot be made at this time.

8.0 RECOMMENDATIONS

Based on the physical characteristics and the location and possible distribution of WWII wrecks in Iron Bottom Sound, further and detailed assessment of environmental impacts and contamination risk, especially specific risk, should incorporate additional environmental variables. These variables will assist in further understanding of wreck distribution and their possible levels of contamination to the coastal and marine environment.

Based on the available bathymetric distribution of some of the wrecks, and the relatively deep ocean in Iron Bottom sound, it is recommended that further studies be concentrated in the shallow nearshore/coastal areas. These area, are the zones of high biological productivity, and concentration of marine biota, including reef species. It is also the area the most assessable to people on the surrounding islands and the areas in which human contact is the most frequent.

Further studies should include,

- further information on the location of nearshore wrecks, especially within the 100m bathymetric contour, for which positions are unknown;
- identification of the aerial distribution of nearshore wrecks by swath or sonar mapping;
- assessment of the nature of ecosystems in the above mentioned nearshore areas;
- assessment of the levels of contamination of nearshore water and sediments, by various trace and heavy metals and petroleum hydrocarbons (both dissolved and dispersed petroleum hydrocarbons) which may be leaching from nearshore vessels into the surrounding water masses and sediment;
- the assessment of water and sediment chemistry parameters should utilise control stations, from which background/normal concentration of the various chemical parameters can be assessed. If this is not done, assessment of water and sediment contamination will be meaningless.

For sound environmental management of the nearshore and marine areas and to facilitate a rational use of the nearshore resources of the area, the assessment of the above parameters should be done. Only then can optimum environmental management strategies be drafted and formulated for the study area.
### Abbreviations used for the various classes of vessels listed in Tables 2 – 6

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<tr>
<th>Abbreviation</th>
<th>Description</th>
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Contamination Risk Assessment, Iron Bottom Sound, Solomon Islands

Table 3. Catalog of US Naval vessels sunk during operation Cactus, Iron Bottom Sound, Solomon Islands, WWII.

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<td>Langga</td>
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<td>Savo Is.</td>
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<td>?</td>
<td>?</td>
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<td>42.10.12</td>
<td>Torpedo/Air</td>
<td>Esperance</td>
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<td>?</td>
<td>?</td>
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<td>?</td>
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<td>CAUSE OF SINKING</td>
<td>AREA</td>
<td>LATITUDE</td>
<td>LONGITUDE</td>
<td>WATER DEPTH (m)</td>
<td>REMARKS</td>
</tr>
<tr>
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<td>?</td>
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<td>?</td>
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<td>Guadalcanal</td>
<td>?</td>
<td>?</td>
<td>800</td>
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<td>DD</td>
<td>USN</td>
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<td>Air attack</td>
<td>Guadalcanal</td>
<td>NE Cape Esperance</td>
<td>600 - 800</td>
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<td>US27</td>
<td>Benham</td>
<td>DD</td>
<td>USN</td>
<td></td>
<td>42.11.15</td>
<td>Air &amp; Sea attack</td>
<td>Guadalcanal</td>
<td>?</td>
<td>?</td>
<td>800</td>
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<td>?</td>
<td>?</td>
<td>800</td>
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<td>Walke (1)</td>
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<td>USN</td>
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<td>Guadalcanal</td>
<td>?</td>
<td>?</td>
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<tr>
<td>US30</td>
<td>Dehaven (1)</td>
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<td>USN</td>
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<td>43.2.1</td>
<td>Air attack</td>
<td>S. Savo Is.</td>
<td>?</td>
<td>?</td>
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<td>Bruno</td>
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<td>?</td>
<td>?</td>
<td></td>
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<td>US32</td>
<td>Colhoun (1)</td>
<td>DD</td>
<td>USN</td>
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<td>42.22.26</td>
<td>Air attack</td>
<td>Guadalcanal</td>
<td>?</td>
<td>?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>US33</td>
<td>Gregory (1)</td>
<td>DD</td>
<td>USN</td>
<td></td>
<td>42.9.5</td>
<td>Air attack</td>
<td>Off Lungga</td>
<td>9°20'S 160°01'E</td>
<td>400</td>
<td></td>
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<tr>
<td>US34</td>
<td>Little (1)</td>
<td>DD</td>
<td>DD</td>
<td>USN</td>
<td>42.9.5</td>
<td>Air attack</td>
<td>Guadalcanal</td>
<td>?</td>
<td>?</td>
<td></td>
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</tr>
<tr>
<td>US35</td>
<td>John Penn</td>
<td>APA</td>
<td>USN</td>
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<td>43.8.13</td>
<td>Air attack</td>
<td>Tenaru Bay</td>
<td>9° 23'N 160° 30'E</td>
<td>450</td>
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<tr>
<td>US36</td>
<td>Canea</td>
<td>AP</td>
<td>USN</td>
<td></td>
<td>43.2.1</td>
<td>Air attack</td>
<td>Tulagi</td>
<td>9° 17'S 160° 02'E</td>
<td>500</td>
<td>Iron Bottom Sound</td>
<td></td>
</tr>
<tr>
<td>US37</td>
<td>Seminole</td>
<td>Tug</td>
<td>USN</td>
<td></td>
<td>43.2.1</td>
<td>Air attack</td>
<td>Lungga</td>
<td>?</td>
<td>?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>US38</td>
<td>Blue (1)</td>
<td>DD</td>
<td>USN</td>
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<td>42.22.26</td>
<td>Air attack</td>
<td>Lungga</td>
<td>?</td>
<td>?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>US39</td>
<td>Aaron (1)</td>
<td>DD</td>
<td>USN</td>
<td></td>
<td>43.4.7</td>
<td>Air attack</td>
<td>Lungga</td>
<td>?</td>
<td>?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>US40</td>
<td>AP 13</td>
<td>DD</td>
<td>USN</td>
<td></td>
<td>43.1.30</td>
<td>Air attack</td>
<td>Lungga</td>
<td>11°25'S 160°56'E</td>
<td></td>
<td>Rennell Is.</td>
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<td>US41</td>
<td>Sesinor</td>
<td>DD</td>
<td>USN</td>
<td></td>
<td>43.1.30</td>
<td>Air attack</td>
<td>Lungga</td>
<td>9° 24'S 160°01'E</td>
<td>50</td>
<td>Location Unknown</td>
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</tr>
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<td>US42</td>
<td>Chicago</td>
<td>CA/DD</td>
<td>USN</td>
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<td>43.1.30</td>
<td>Air attack</td>
<td>Lungga</td>
<td>11°25'S 160°56'E</td>
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<td>Rennell Is.</td>
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<td>Gulbourn</td>
<td>APD</td>
<td>USN</td>
<td></td>
<td>42.08.30</td>
<td>Sea attack</td>
<td>Lungga</td>
<td>9°24'S 160°01'E</td>
<td>50</td>
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<td>PT123</td>
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<td>USN</td>
<td></td>
<td>43.2.1</td>
<td>Sea attack</td>
<td>Iron Bottom Sound</td>
<td>?</td>
<td>?</td>
<td></td>
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</table>
Table 4. Details of New Zealand Naval vessel sunk during operation Cactus, Iron Bottom Sound, Solomon Islands, WW II.

<table>
<thead>
<tr>
<th>ENTRY CODE</th>
<th>NAME</th>
<th>CLASS OF VESSEL</th>
<th>OWNER</th>
<th>TONNAGE</th>
<th>DATE DESTROYED</th>
<th>CAUSE OF SINKING</th>
<th>AREA</th>
<th>LATITUDE</th>
<th>LONGITUDE</th>
<th>WATER DEPTH (m)</th>
<th>REMARKS</th>
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</thead>
</table>

Table 5. Details of Australian Naval vessel sunk during operation Cactus, Iron Bottom Sound, Solomon Islands, WW II.

<table>
<thead>
<tr>
<th>ENTRY CODE</th>
<th>NAME</th>
<th>CLASS OF VESSEL</th>
<th>OWNER</th>
<th>TONNAGE</th>
<th>DATE DESTROYED</th>
<th>CAUSE OF SINKING</th>
<th>AREA</th>
<th>LATITUDE</th>
<th>LONGITUDE</th>
<th>WATER DEPTH (m)</th>
<th>REMARKS</th>
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<tbody>
<tr>
<td>RAN 1</td>
<td>Canberra</td>
<td>CA</td>
<td>RAN</td>
<td>?</td>
<td>42.8.9</td>
<td>Sea attack</td>
<td>SE of Savo Is</td>
<td>?</td>
<td>?</td>
<td>650-750 m</td>
<td>Exact location unknown</td>
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Table 6. Total number of US and Japanese naval vessels damaged and sunk and plane losses, WW II, Iron Bottom Sound, Solomon Islands.

<table>
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<tr>
<th>Vessel</th>
<th>Numbers</th>
<th>Vessel</th>
<th>Numbers</th>
<th>US Plane</th>
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<tbody>
<tr>
<td>BB</td>
<td>2</td>
<td>CA</td>
<td>6</td>
<td>330</td>
</tr>
<tr>
<td>CA</td>
<td>11</td>
<td>CV</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>CV</td>
<td>2</td>
<td>CL</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>CL</td>
<td>1</td>
<td>DD/APD</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>DD/AVD</td>
<td>11</td>
<td>SS</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>SS</td>
<td>1</td>
<td>AP/AK</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>AP/AK/AO</td>
<td>6</td>
<td>PT</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>PT</td>
<td>3</td>
<td>YP</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>AT</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>SUB TOTAL</strong></td>
<td><strong>37</strong></td>
<td><strong>40</strong></td>
<td></td>
<td><strong>330</strong></td>
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<table>
<thead>
<tr>
<th>JAPANESE VESSELS DAMAGED</th>
<th>JAPANESE VESSELS SUNK</th>
<th>JAPANESE PLANES LOSSES</th>
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<td>Vessel Class</td>
<td>Numbers</td>
<td>Vessel Class</td>
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<td>BB</td>
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<td>BB</td>
</tr>
<tr>
<td>CA</td>
<td>15</td>
<td>CA</td>
</tr>
<tr>
<td>CV</td>
<td>3</td>
<td>CV</td>
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<td>CL</td>
<td>13</td>
<td>CL</td>
</tr>
<tr>
<td>DD/DE/PG</td>
<td>43</td>
<td>DD</td>
</tr>
<tr>
<td>SS</td>
<td>3</td>
<td>PE PC/PG</td>
</tr>
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<td>AP/AK/AO</td>
<td>70</td>
<td>SS</td>
</tr>
<tr>
<td>AV</td>
<td>2</td>
<td>AP/AK/AO</td>
</tr>
<tr>
<td>PG</td>
<td>1</td>
<td>AK</td>
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<tr>
<td>DM</td>
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<tr>
<td><strong>SUB TOTAL</strong></td>
<td><strong>154</strong></td>
<td><strong>81-105</strong></td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>191</strong></td>
<td><strong>121-145</strong></td>
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Contamination Risk Assessment, Iron Bottom Sound, Solomon Islands

Table 7. Aircraft types used in WW II, Iron Bottom Sound, Solomon Islands.

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<th>MODEL</th>
<th>TYPE</th>
<th>LOCATION</th>
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<td>Grumman</td>
<td>F4F-4</td>
<td>Wildcat</td>
<td>Guadalcanal</td>
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<tr>
<td>Grumman</td>
<td>TBF-1</td>
<td>Avenger</td>
<td>Honiara/Guadalcanal</td>
</tr>
<tr>
<td>Lockheed</td>
<td>PV-1</td>
<td>Ventura</td>
<td>Honiara/Guadalcanal</td>
</tr>
<tr>
<td>Douglas</td>
<td>SBD-5</td>
<td>Dauntless-Dive Bombers</td>
<td>Guadalcanal</td>
</tr>
<tr>
<td>Mitsubishi</td>
<td>A6M Zero - Sen</td>
<td>Zeke</td>
<td>Guadalcanal</td>
</tr>
<tr>
<td>Mitsubishi</td>
<td>G4M - 1</td>
<td>Betty-Bombers</td>
<td>Guadalcanal</td>
</tr>
<tr>
<td>Mitsubishi</td>
<td>A6M - 2</td>
<td>Zeke-Bombers</td>
<td>Guadalcanal</td>
</tr>
<tr>
<td>Mitsubishi</td>
<td>A6M - 3</td>
<td>Zeke-Bombers</td>
<td>Guadalcanal</td>
</tr>
<tr>
<td>USA (make unknown)</td>
<td>B17</td>
<td>Flying Fortress Bomber</td>
<td>Guadalcanal</td>
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</table>
## Table 8. Comparative table of the main types of fighter airplane, WW II, Iron Bottom Sound, Solomon Islands.

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>Length (feet)</th>
<th>Span (feet)</th>
<th>Engine (hp)</th>
<th>Max Speed (mph)/altitude (feet)</th>
<th>Range normal/max (miles)</th>
<th>Armament</th>
<th>Number Built</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>U.S. Navy</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F4F-4 Wildcat</td>
<td>28'9&quot;</td>
<td>38'0&quot;</td>
<td>Pratt &amp; Whitney R-1 830-86 (1,200)</td>
<td>320/19 400</td>
<td>910/1250</td>
<td>4 x (later 6) .50-cal. Machine guns</td>
<td>1168</td>
</tr>
<tr>
<td>4U-1 Corsair</td>
<td>33'4&quot;</td>
<td>41'0&quot;</td>
<td>Pratt &amp; Whitney R-2830-8 (2,000)</td>
<td>417/19 900</td>
<td>1,015/1562</td>
<td>6x .50-cal. machine guns</td>
<td>9444¹</td>
</tr>
<tr>
<td><strong>USAAF</strong></td>
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<td></td>
</tr>
<tr>
<td>P-400 (P-39D)</td>
<td>30'2&quot;</td>
<td>34'0&quot;</td>
<td>Allison V-1710 (1,150)</td>
<td>335/5000</td>
<td>600/1100</td>
<td>1x20mm can. 4x.30-cal. 2x.50-cal. Machine guns</td>
<td>179²</td>
</tr>
<tr>
<td>Airacobra</td>
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<tr>
<td>P-40E Warhawk</td>
<td>31'2&quot;</td>
<td>37'4&quot;</td>
<td>Allison V-1710 (1,150)</td>
<td>335/5000</td>
<td>650/850</td>
<td>6x.50-cal. machine guns</td>
<td>2320</td>
</tr>
<tr>
<td><strong>Japanese Navy</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>A6M2 Model 21</td>
<td>29'8&quot;</td>
<td>39'4&quot;</td>
<td>Nakajima Sakai 12 (925)</td>
<td>331/15 000</td>
<td>1,160/1930</td>
<td>2x20mm can. 2x7.7mm machine guns</td>
<td>1100³</td>
</tr>
<tr>
<td>Zero-sen (Zeke)</td>
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<td></td>
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</tr>
<tr>
<td>A6M2-N (Rufe)</td>
<td>33'1&quot;</td>
<td>39'4&quot;</td>
<td>Nakajima Sakai 12 (925)</td>
<td>270/16 400</td>
<td>714/1107</td>
<td>2x20mm can. 2x7.7mm machine guns</td>
<td>327</td>
</tr>
<tr>
<td><strong>Japanese Army</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ki, +3.1A Yayabusa (Oscar)</td>
<td>26'11&quot;</td>
<td>37'6&quot;</td>
<td>Nakajima Ha-25 (950)</td>
<td>308/13 100</td>
<td>745 max</td>
<td>2x7.7mm or 12.7mm machine guns</td>
<td>716</td>
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<tr>
<td>Ki,61-1a Hien (Tony)</td>
<td>28'8&quot;</td>
<td>39'4&quot;</td>
<td>Kawasaki Ha-40 (1,175)</td>
<td>368/16 000</td>
<td>373/684</td>
<td>2x12.7mm 2x7.7mm machine guns</td>
<td>1380</td>
</tr>
</tbody>
</table>
9.0 BIBLIOGRAPHY - SOURCES OF DATA


10.0 REFERENCES CITED


Plate 1. Oblique aerial view, looking southwest, of Cape Esperance, Guadalcanal's northwest coast, Iron Bottom Sound. Note the extensive coral reef growth in the foreground and close to the shore and the sallower lagoon (light blue) in the background. A well-developed deeper (darker blue) channel separates the lagoon from the shore, suggesting effective circulation and proper tidal flushing of these nearshore areas. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.
Plate 2. Oblique aerial view, looking east-northeast, of Henderson Airfield Guadalcanal, October 1942. Note the numerous US airforce fighter planes at base and the naval vessel in the nearshore areas of Iron Bottom Sound (in the background). Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.

Plate 3. The USS Chicago, a few hours before sinking in the Solomon’s. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.
Plate 4. The HM-NZS Tui, a New Zealand Navy minesweeper used primarily in anti-submarine operations during the Guadalcanal offensive 1942-1943. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.

Plate 5. Douglas, SBD-5 Dauntless-Dive Bombers in action, a typical aircraft destroyed over Iron Bottom Sound. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.
Plate 6. A squadron of **Lockheed, PV-1 Ventura US** fighter planes at Henderson Airfield, November 1942. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.

Plate 7. **WW II** photograph of Henderson Airfield, December 1942, with a **Grumman, F4F-4 Wildcat** fighter. Photo reproduced with the kind courtesy Solomon Islands Philatelic Bureau, Honiara.
Plate 8. Night action off Savo Island, 1st Battle of Savo, August 1942. Photo reproduced with the kind courtesy Solomon Islands Philatelic Bureau, Honiara.

Plate 10. Air attack over Iron Bottom Sound, by Mitsubishi, G4M-1 Betty Bombers, 8th August 1942. Photo reproduced with the kind courtesy Solomon Islands Philatelic Bureau, Honiara.

Plate 11. An underwater photograph of a battleship in Iron Bottom Sound. Note the heavily encrusted and highly corroded metal surface. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.
Plate 12. Underwater photograph of a battleship in Iron Bottom Sound. Note the heavily encrusted and highly corroded metal surface. Encrustation of various types of marine algae and small corals are common. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.

Plate 13. A diver inspects a sunken WW II naval wreck off Guadalcanal shores. This wreck, like many others, which litter the sea floor of Iron Bottom Sound, offer a haven of interesting sights and scene for the keen diver. The large surface area of these wrecks provides additional encrusting surfaces for benthic marine dwellers, in particular, isolated corals and algae. These attract fish population, also increasing local marine biodiversity. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.
Plate 14. Divers inspect the cockpit and control column of a US B-17E, Flying Fortress Bomber aircraft destroyed in Iron Bottom Sound, 24th September 1942. Note the heavily encrusted metal surface, finger corals on the left; red and green algae and other benthic biota. Note the prolific growth of algae on the gun turret in the background. Encrustation by various marine algae is common. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.

Plate 15. Underwater photograph of a section of an aircraft in Iron Bottom Sound. Note the heavily encrusted and highly corroded metal surface. Encrustation of various types of marine algae and small corals are common. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.
Plate 16. Underwater photograph of an aircraft in Iron Bottom Sound. Note the heavily encrusted and highly corroded metal surface. Encrustation of various types of marine algae and small corals are common. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.

Plate 17. Underwater photograph of a submarine in Iron Bottom Sound. Note the heavily encrusted and highly corroded metal surface. Encrustation of various types of marine algae and small corals are common. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.
Plate 18. Underwater photograph of a Mitsubishi, A6M Zero-Sen Zeke aircraft in Iron Bottom Sound. It has been described as the fastest fighter aircraft of the Guadalcanal campaign in the Pacific Theatre and of World War II at that time. Note the heavily encrusted metal surface. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.

Plate 19. Underwater photograph of the cockpit area of a Grumman, F4F-4 Wildcat aircraft in Iron Bottom Sound. Note the heavily encrusted metal surface. Encrustation of various marine algae is common. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.
Plate 20. Underwater photograph of the cockpit of a Grumman, F4F-4 Wildcat aircraft in Iron Bottom Sound. The Wildcat was the principal US Navy fighter plane and described by military historians as the first successful western shipboard fighter monoplane. Note the heavy encrustation of various types of marine algae. These wrecks support considerable benthic marine biota, adding to the productivity of the nearshore coastal region. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.

Plate 22. Beached Japanese Navy transport vessels on the shores of Guadalcanal, 14th October 1942. The Kinugawa Maru, a 6,936 Tonne vessel, forced to this fate, after it also came under attack from Allied Forces. This vessel, together with the Hirokawa Maru, can be seen on the shores of Guadalcanal Island, near Tasivarongo Point. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.

Plate 23. Beached Japanese Navy transport vessels on the shores of Guadalcanal, 14th October 1942. The Hirokawa Maru, a 6,872 Tonne vessel, forced to this fate, after it came under attack from Allied Forces. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.
Plate 24. Rifle ammunition on one of the Japanese transport vessels in coastal areas of Iron Bottom Sound, north Guadalcanal. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.

Plate 25. Preparing to destroy remaining WW II explosives on the north shores of Guadalcanal, Iron Bottom Sound. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.
APPENDIX I

TERMS OF REFERENCE FOR THE PROJECT AND SOPAC/UNDP CONTRACT

CONTAMINATION RISK ASSESSMENT FROM
WWII SUNKEN VESSELS  IRON BOTTOM SOUND, SOLOMON ISLANDS:
SOPAC PROJECT - SB 99.03

Objectives
To compile an inventory in GIS-based format of sunken ships and aeroplanes (if possible) in Iron Bottom Sound, Solomon Islands.

Background
Many areas within the Pacific were subject to intense military activity during WW II, resulting in the sinking of numerous military ships and aircraft. Solomon Islands was one particular area where fighting over a span of 5 years, saw the loss of some 100 plus ships in coastal waters. For these ships and aircraft little is known of about the cargo content at the time of sinking, their location, water depth and therefore the potential hazards risks posed to marine biodiversity, the impacts on sustainability of commercial fisheries, tourism, and other marine-based economic activities.

Equipment and Resources
Access to pre-existing sources of information.

Work Program

- Compile as complete an inventory as possible, on number of vessels, probable cargo content using data from as wide a variety of sources as possible in the time available, such as war archives in Washington, Bishop Museum, Tokyo and Honiara.

- Develop a database in GIS with overlays of vessel location, water depth, oceanographic conditions where available, such as currents and water quality.

- Preliminary definition of areas of potential environmental impact.

- Define a follow-up work plan as may be necessary.

Output
Inventory of ships, locations, water depths cargo content in GIS MapInfo format, together with recommendations, as may be necessary, for further field investigations of selected areas to assist in developing sustainable planning and management measures.

Client
Solomon Islands Government (SIG).

Technical Personnel/Professional Staff
SOPAC Coastal and Information Technology Units